Notice of Allowability	Application No.	Applicant(s)	
	09/536,820	HUANG ET AL.	
	Examiner	Art Unit	
	Virginia M Kibler	2623	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *After Final Amendment filed 10/27/04*.

2. ☒ The allowed claim(s) is/are *7, 8, 17, 18, 27, 28, and 32-34 (renumbered 1-9)*.

3. ☒ The drawings filed on *22 June 2000* are accepted by the Examiner.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
      1. ☐ Certified copies of the priority documents have been received.
      2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application (PTO-152)
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☒ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

DETAILED ACTION

EXAMINER'S AMENDMENT

1. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with Richard Lyon (Reg. No. 37,385) on 12/16/04.

The application has been amended as follows:

In the Claims:

7. (currently amended) ~~The process of Claim 6, wherein the fusing neural network~~ A computer-implemented face recognition process for identifying a person depicted in an input image, comprising using a computer to perform the following process actions:

creating a database of a plurality of model image characterizations, each of which represents the face of a known person that it is desired to identify in the input image as well as the person's face pose;

training a neural network ensemble to identify a person and their face pose from a region which has been extracted from said input image and characterized in a manner similar to the plurality of model images, wherein the network ensemble comprises, a first stage having a

plurality of classifiers each of which has input and output units and is dedicated to a particular pose range and outputs a measure of the similarity indicative of the similarity between said characterized input image region and each of said model image characterizations associated with the particular pose range of the classifier, and a fusing neural network as its second stage which combines the outputs of the classifiers to generate an output indicative of the person associated with the characterized input image region and the face pose of that person and which has at least enough output units to allow a different output to represent each person it is desired to identify at each of the pose ranges, and wherein ~~the process action of training the neural network ensemble further comprises the actions of:~~ training the neural network ensemble comprises,

preparing each model image characterization from a model image depicting the face of a known person that it is desired to identify in the input image by,

extracting the portion of the model image depicting said face,

normalizing the extracted portion of the model image by resizing it to a prescribed scale if not already at the prescribed scale and adjusting the region so that the eye locations of the depicted subject fall within a prescribed area, and

cropping the extracted portion of the model image by eliminating unneeded portions of the image not specifically depicting part of the face of the subject to create a model face image,

categorizing the model face images by assigning each to one of a set of pose ranges into which its associated face pose falls, and

for each pose range,

choosing a prescribed number of the model face images of each person being modeled which have been assigned to the selected pose range,

concatenating each of the chosen model face images to create a respective dimensional column vector (DCV) for each,

computing a covariance matrix from the DCVs,

calculating eigenvectors and corresponding eigenvalues from the covariance matrix,

ranking the eigenvalues in descending order,

identifying a prescribed number of the top eigenvalues,

using the eigenvectors corresponding to the identified eigenvalues to form the rows of a basis vector matrix (BVM) for the pose range, and

multiplying each DCV by each BVM to produce a set of principal components analysis (PCA) coefficient vectors for each model face image, and

for each face recognition neural network, inputting, one at a time, each of the PCA coefficient vectors associated with the pose range of the face recognition neural network into the inputs of the network until the outputs of the network stabilize,[[;]]

initializing the fusing neural network for training,[[;]]

for each DCV, simultaneously inputting the PCA coefficient vectors generated from the DCV into the respective face recognition neural network associated with the vector's particular pose range group until all the PCA coefficient vectors of every DCV have been input, and repeating until the outputs of the fusing neural network stabilize,[[;]] and

for each DCV, simultaneously inputting the PCA coefficient vectors generated from the DCV into the respective face recognition neural network associated with the vector's particular pose range group and assigning the active output of the fusing neural network as corresponding to the particular person and pose associated with the model image used to create the set of PCA coefficient vectors; and

employing the network ensemble to identify the person associated with the characterized input image region and the face pose of that person.

8. (~~previously presented~~ currently amended) The process of Claim 7, wherein the process action of employing the neural network ensemble to identify the person depicted in the input image face region, comprises the actions of:

preparing the face region extracted from an input image by normalizing and cropping the extracted regions, wherein said normalizing comprises resizing the extracted face region to the same prescribed scale if not already at the prescribed scale and adjusting the region so that the eye locations of the depicted subject fall within a prescribed area, and wherein the cropping comprises ~~eliminated~~ eliminating unneeded portions of the image not specifically depicting part of the face of the subject;

concatenating the prepared face region to create a DCV;

multiplying the DCV by each BVM to produce a set of PCA coefficient vectors for the extracted face region;

inputting each PCA coefficient vector in the set of PCA coefficient vectors into the respective face recognition neural network associated with that vector's particular pose range group; and

identifying the active unit of the output of the fusing neural network and designating the person and pose previously assigned to that unit as the person and pose associated with the extracted face region.

17. (currently amended) ~~The system of Claim 16, wherein the fusing neural network~~ A face recognition system for identifying a person depicted in an input image, comprising:

a general purpose computing device; and

a computer program comprising program modules executable by the computing device, wherein the computing device is directed by the program modules of the computer program to,

capture model images, each of which depicts at least one person of known identity,

locate and extract regions within the model images, each of which depicts the face of a known person that it is desired to identify in the input image,

determine the face pose for each of the face regions extracted from the model images,

categorize each face region by assigning each to one of a set of pose ranges into which its associated face pose falls,

train a neural network ensemble to identify a person and their face pose

from a region that depicts the face of a person which has been extracted from said input image, wherein the network ensemble comprises, a first stage having a plurality of classifiers each of which has input and output units and is dedicated to a particular pose range and outputs a measure of the similarity indicative of the similarity between said input image region and each of said model image regions associated with the particular pose range of the classifier, and a fusing neural network as its second stage which combines the outputs of the classifiers to generate an output indicative of the person associated with the characterized input image region and the face pose of that person and which has at least enough output units to allow a different output to represent each person it is desired to identify at each of the pose ranges, and wherein ~~the sub-module for training the neural network ensemble further comprises sub-modules for:~~ training the neural network ensemble comprises,

(a) preparing each face region extracted from said model images by normalizing and cropping the extracted regions, wherein said normalizing comprises resizing each extracted face region to the same prescribed scale if not already at the prescribed scale and adjusting each region so that the eye locations of the depicted subject fall within the same prescribed area, and wherein said cropping comprises eliminating unneeded portions of the image not specifically depicting part of the face of the subject,

(b) selecting a previously unselected one of the set of pose ranges,

(c) choosing a prescribed number of the prepared face images of each person being modeled which have been assigned to the selected pose range,

(d) concatenating each of the chosen prepared face images to create a respective dimensional column vector (DCV) for each,

(e) computing a covariance matrix from the DCVs,

(f) calculating eigenvectors and corresponding eigenvalues from the covariance matrix,

(g) ranking the eigenvalues in descending order,

(h) identifying a prescribed number of the top eigenvalues,

(i) using the eigenvectors corresponding to the identified eigenvalues to form the rows of a basis vector matrix (BVM) for the selected pose range,

(j) repeating actions (b) through (i) for each remaining pose range,

(k) multiplying each DCV by each BVM to produce a set of principal components analysis (PCA) coefficient vectors for each face image,

(l) for each face recognition neural network, inputting, one at a time, each of the PCA coefficient vectors associated with the pose range of the face recognition neural network into the inputs of the network until the outputs of the network stabilize,[[;]]

(m) initializing the fusing neural network for training,[[;]]

(n) for each DCV, simultaneously inputting the PCA coefficient vectors generated from the DCV into the respective face recognition neural network associated with the vector's particular pose range group until all the PCA coefficient vectors of every DCV have been input, and repeating until the outputs of the fusing neural network stabilize,[[;]] and

(o) for each DCV, simultaneously inputting the PCA coefficient vectors generated from the DCV into the respective face recognition neural network associated with the vector's particular pose range group and assigning the active output of the fusing neural network as corresponding to the particular person and pose associated with the model image used to create the set of PCA coefficient vectors, and

employ the network ensemble to identify the person associated with the characterized input image region and their face pose.

18. (~~original~~ currently amended) The system of Claim 17, wherein the ~~sub-module~~ module for employing the neural network ensemble to identify the person depicted in the input image face region and the pose associated with the face of the identified person, comprises sub-modules for:

preparing the face region extracted from an input image by normalizing and cropping the extracted regions, wherein said normalizing comprises resizing the extracted face region to the same prescribed scale if not already at the prescribed scale and adjusting the region so that the eye locations of the depicted subject fall within a prescribed area, and wherein the cropping comprises ~~eliminated~~ eliminating unneeded portions of the image not specifically depicting part of the face of the subject;

concatenating the prepared face region to create a DCV;

multiplying the DCV by each BVM to produce a set of PCA coefficient vectors for the extracted face region;

inputting each PCA coefficient vector in the set of PCA coefficient vectors into the respective face recognition neural network associated with that vector's particular pose range group; and

identifying the active unit of the output of the fusing neural network and designating the person and pose previously assigned to that unit as the person and pose associated with the extracted face region.

27. (currently amended) ~~The computer-readable memory of Claim 26, wherein the fusing neural network~~ A computer-readable memory for use in identifying a person depicted in an input image, comprising:

a computer-readable storage medium; and

a computer program comprising program modules stored in the storage medium, wherein the storage medium is so configured by the computer program that it causes a computer to,

input model images, each of which depicts at least one person of known identity,

locate and extract regions within the model images, each of which depicts the face of a known person that it is desired to identify in the input image,

determine the face pose for each of the face regions extracted from the model images,

categorize each face region by assigning each to one of a set of pose ranges into which its associated face pose falls,

train a neural network ensemble to identify a person and their face pose from a region that depicts the face of a person which has been extracted from said input image, wherein the network ensemble comprises, a first stage having a plurality of classifiers each of which has input and output units and is dedicated to a particular pose range and outputs a measure of the similarity indicative of the similarity between said input image region and each of said model image regions associated with the particular pose range of the classifier, and a fusing neural network as its second stage which combines the outputs of the classifiers to generate an output indicative of the person associated with the characterized input image region and the face pose of that person and which has at least enough output units to allow a different output to represent each person it is desired to identify at each of the pose ranges, and wherein ~~the sub-module for training the neural network ensemble further comprises sub-modules for:~~ training the neural network ensemble comprises,

(a) preparing each face region extracted from said model images by normalizing and cropping the extracted regions, wherein said normalizing comprises resizing each extracted face region to the same prescribed scale if not already at the prescribed scale and adjusting each region so that the eye locations of the depicted subject fall within the same prescribed area, and wherein said cropping comprises eliminating unneeded portions of the image not specifically depicting part of the face of the subject,

(b) selecting a previously unselected one of the set of pose ranges,

(c) choosing a prescribed number of the prepared face images of each person being modeled which have been assigned to the selected pose range,

(d) concatenating each of the chosen prepared face images to create a respective dimensional column vector (DCV) for each,

(e) computing a covariance matrix from the DCVs,

(f) calculating eigenvectors and corresponding eigenvalues from the covariance matrix,

(g) ranking the eigenvalues in descending order,

(h) identifying a prescribed number of the top eigenvalues,

(i) using the eigenvectors corresponding to the identified eigenvalues to form the rows of a basis vector matrix (BVM) for the selected pose range,

(j) repeating actions (b) through (i) for each remaining pose range,

(k) multiplying each DCV by each BVM to produce a set of principal components analysis (PCA) coefficient vectors for each face image,

(l) for each face recognition neural network, inputting, one at a time, each of the PCA coefficient vectors associated with the pose range of the face recognition neural network into the inputs of the network until the outputs of the network stabilize,[[;]]

(m) initializing the fusing neural network for training,[[;]]

(n) for each DCV, simultaneously inputting the PCA coefficient vectors generated from the DCV into the respective face recognition neural network associated with the vector's particular pose range group until all the PCA coefficient vectors of every DCV have been input, and repeating until the outputs of the fusing neural network stabilize,[[;]] and

(o) for each DCV, simultaneously inputting the PCA coefficient vectors generated from the DCV into the respective face recognition neural network associated with the vector's particular pose range group and assigning the active output of the fusing neural network as corresponding to the particular person and pose associated with the model image used to create the set of PCA coefficient vectors, and

employ the network ensemble to identify the person associated with the characterized input image region and their face pose.

28. (~~original~~ currently amended) The computer-readable memory of Claim 27 wherein the ~~sub-module~~ module for employing the neural network ensemble to identify the person depicted in the input image face region and the pose associated with the face of the identified person, comprises sub-modules for:

preparing the face region extracted form an input image by normalizing and cropping the extracted regions, wherein said normalizing comprises resizing the extracted face region to the same prescribed scale if not already at the prescribed scale and adjusting the region so that the eye locations of the depicted subject fall within a prescribed area, and wherein the cropping comprises ~~eliminated~~ eliminating unneeded portions of the image not specifically depicting part of the face of the subject;

concatenating the prepared face region to create a DCV;

multiplying the DCV by each BVM to produce a set of PCA coefficient vectors for the extracted face region;

inputting each PCA coefficient vector in the set of PCA coefficient vectors into the respective face recognition neural network associated with that vector's particular pose range group; and

identifying the active unit of the output of the fusing neural network and designating the person and pose previously assigned to that unit as the person and pose associated with the extracted face region.

33. (~~previously presented~~ currently amended) The process of Claim 32, wherein the process action of employing the network ensemble to identify the person depicted in the input image face region, comprises the actions of:

preparing the face region extracted from an input image by normalizing and cropping the extracted regions, wherein said normalizing comprises resizing the extracted face region to the same prescribed scale if not already at the prescribed scale and adjusting the region so that the eye locations of the depicted subject fall within a prescribed area, and wherein the cropping comprises ~~eliminated~~ eliminating unneeded portions of the image not specifically depicting part of the face of the subject;

concatenating the prepared face region to create a DCV;

inputting the DCV of the face region into all classifiers; and

identifying the active output of the neural network and designating the person previously assigned to that unit as the person associated with the extracted face region.

REASONS FOR ALLOWANCE

2. The following is an examiner's statement of reasons for allowance: the instant invention replaces the known face recognition. The essential difference from the prior art is that the instant invention uses prepared face image representations to train a neural network ensemble including a first stage of classifiers each dedicated to a particular pose range and a second stage in the form of a singe fusing neural network. The face images are preprocessed in order to create the prepared face image representations including normalizing, cropping, categorizing, and abstracting extracted image regions so as to facilitate the comparison process. The abstracting procedure represents the images in a simper form to reduce the processing necessary in comparison which entails the use of eigenface representations and the creation of PCA coefficient vectors to represent each normalized and cropped face image. The eigenface approach entails first assigning a prescribed number of the normalized and cropped face images associated with each person being modeled to a selected pose range group. Each of these assigned face images is then concatenated to create respective DCVs. PCA vectors are generated by multiplying a DCV by the BVM associated with the pose range group of the selected face recognition neural network. The face recognition neural networks of the first stage of the ensemble are trained by inputting, one at a time, each of the PCA coefficient vectors associated with the pose range group of a selected face recognition neural network into the inputs of that neural network. This is repeated until the outputs of the selected face recognition neural network stabilize. The fusing network is initialized for training. The PCA coefficient vectors generated from a particular DCV are simultaneously input into the respective face recognition neural

network associated with the vector's particular pose range group. This is repeated for each set of PCA coefficient vectors. Therefore, the instant invention identifies the person and face pose of an image with reduced processing required thereby facilitating the comparison process. These features in combination with the other elements of the claims are not disclosed or suggested by the prior art of record.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

CONTACT INFORMATION

3. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Virginia M Kibler whose telephone number is (703) 306-4072. The examiner can normally be reached on Mon-Thurs 8:00 - 5:30 and every other Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Virginia Kibler can be reached on (703) 306-4072. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Virginia Kibler
12/15/04

MEHRDAD DASTOURI
PRIMARY EXAMINER